MECHELECIV

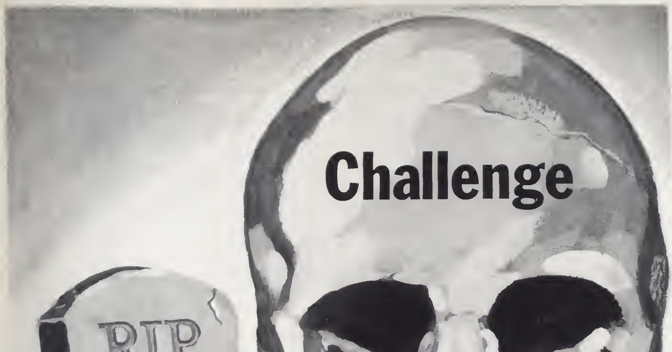
23

THE STUDENTS MAGAZINE • VOL. 28 • DECEMBER 1969 • NO. 3
MEMBER OF ENGINEERING COLLEGE MAGAZINES ASSOCIATED

GWU/NASA Technology Utilization Program
Summer Institute in Biomedical Engineering

THE GEORGE WASHINGTON UNIVERSITY

SCHOOL OF ENGINEERING AND APPLIED SCIENCE


Challenge
RIP
Here lies the
word
"Challenge,"
dead
of overwork
and
overexposure

MECHELECIV

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FEATURE

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COVER

Summer Institute for Biomedical Research in Technology Utilization – GWU/NASA program in which GWU SEAS undergraduate engineers participated.

FRONTISPIECE

No-wait loading is provided by Goodyear's Carveyor minidistance transportation system, a model of which will be on display Feb. 22-28 at the GWU SEAS Open House.

Member
Engineering College Magazine Association
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Oklahoma State University

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MECHELECIV

The main feature of this issue is the Summer Institute for Biomedical Research in Technology Utilization conducted, in co-operation with G.W.U., at the Goddard Space Flight Center in Greenbelt, Maryland. As a student who participated in the Summer Institute, I would like to take this space to add my comments from the students' viewpoint to those made by Mr. Jacobs in his article.

During the course of the past few years, the opportunities for undergraduate engineers to obtain meaningful and educational summer employment in Government agencies has steadily declined to the point that they are next to impossible to find. Those undergraduates who are lucky enough to be placed in a summer job with the Government usually find themselves in a job which offers little except enough trivial work to keep them entertained for three months.

The primary reason for the difficulty to find meaningful jobs seems to be due to the displacement of Government funds for summer work poverty programs as well as a definite lack of planning in the placement of those students who are offered work. It now seems likely that the recent economy moves by the Government will further reduce any employment possibilities available to an undergraduate engineer during his summer break. It was for this reason that it was very gratifying to discover that the George Washington University School of Engineering and Applied Science, in co-operation with N.A.S.A., was giving undergraduate engineers an opportunity to spend their summer working at a Government lab on a research and development project sponsored by the University.

Short of a full scale Co-Op program at other universities (by the way, the S.E.A.S. has also initiated a Co-Op program, see *Mecheleciv,* Nov. '69 "Campus News"), this type of University/Government co-operation is the only program which offers an opportunity for the undergraduate engineer to experience the real-life challenges of the engineering profession.

After talking to several people in industry and Government agencies, they all reported that they usually spend up to one or two years in re-educating the starting engineer to perform *practically* in the engineering profession. All concerned considered this a waste of their time, although all conceded that it was necessary. The colleges and universities must be held responsible for producing this situation. I must admit that this past summer was truly an eye-opening experience. An experience which has added much to my education and has prepared me for the transition from college to the engineering profession. After reading the critiques of the nine other students who participated in the Summer Institute, I found their opinions to be in complete agreement with mine.

Our present circulation sends this magazine to many colleges, universities, industries, and government agencies across the nation. Hopefully, the colleges and universities will take it upon themselves to follow in G.W.U.'s footsteps by participating in this type of co-operation with local industry and Government labs. Educators must agree that the future development of engineering education rests on the universities success in breaking out of the confinement to the classroom by embracing local engineering facilities, with their excellent labs and libraries, as part of the educational community.

The Summer Institute is certainly one solution to the problem of broadening the education given to undergraduate engineers. One which will prepare them for the eye-opening transition from the theoretical world of college to the challenging world of the engineering profession.

David R. Armstrong

LETTERS TO THE EDITOR

CONCERNING LETTERS TO THE EDITOR

Dear Editor:

The "Letter to the Editor" section of most magazines is often the most interesting part of the issue. Electronic hobbyist magazines are no exception to this statement. The letters, written by the varying personalities found in any hobby, can often be categorized into particular recurring types. This article is written as a guide to those interested in the study of these specific types of letters.

The most obvious type of letter is the misplaced one. These often humorous, postal errors are often found in electronic magazines and generally remain unanswered:

"What is the average age of the Mississippi Swamp Turtle?"

"Please tell me the value of an 1895 Flying Eagle cent."

Another recurring theme in these letters is the "I found a mistake that your proofreader missed" type. These letters are found highly useful by the production department of a magazine, which must endeavor to correct future errors of the type mentioned:

"Please insert a comma on page 42, paragraph 2, line 14, directly after the word "Klutz" in your February issue."

"Your drawing of a 50 mfd capacitor on page 19 of the February issue includes wire leads which would appear to be 2.1415 inches long. Measurement of an actual capacitor showed these leads to be 1.906 inches long, or roughly 2.4 times the length of. . ."

The gripe letter is by far the most popular variety. This group usually includes the gripes to the editor about other gripes to the editor:

"Tell Mr. Freebish (February, 1969) to go soak his head. The man is obviously mentally deficient and . . ."

"Let me briefly summarize my objections to the claims of Mr. Freebish (February, 1969). To begin with, I can only say that I felt it imperative that I come to the fore and state my beliefs in black and white while I . . ." (The 5 page text of Mr. Plodnk's letter has been shortened for publication. Ed.)

Equipment modifications are a topic which is limited to hobbyist publications. These requests for information on modification of a specific piece of gear are often rather difficult to honor:

"Do you have any information dealing with the conversion of the Navy ART-113 transmitter to a boat anchor?"

"How can I increase the volume level of my Banshee A1500 500 watt stereo amplifier?"

I recently obtained a surplus TRR gransceiver which was used by the Yugoslavian army until 1949. These are beautiful units, and in excellent condition, however I would like to know what voltage to apply to the jack marked "KNORTZ". Also, perhaps you could tell me the functions of the controls marked "GREGI", INZXIK", and "FERGORKIN."

The last, and most interesting category is the letter to the editor of a newsletter such as this one. These are given such technical names as "blank space", "lower margins", or "nothingness". An example is shown below:

"   "

We hope that the reader will now be able to read "Letters to the Editor" with new insight and interest. If you still do not feel proficient in this practice, try writing a letter to the editor of *MECHELECIV.*

Respectfully submitted by
Charles McCullough, EE '73
"QNC-VHF" Newsletter

* * *

AGREEMENT WITH NOVEMBER EDITORIAL

Dear Mr. Armstrong:

Tuesday evening my husband brought home the November issue of *Mecheleciv* and couldn't resist writing to you – mainly because Earl and I heartily agree with the basic premise of your article that English must be made relevant to the engineer and for the engineer.

I think this communication gap is even more serious than even your article suggests. Not only does an engineer have to get his ideas across to his company or university co-workers, but the pressure to publish is becoming even more intense in our society. My husband just finished his term paper on publishing by engineers.

If the S.E.A.S. ever gets around to offering a course in Engineering Communications, I'd like to suggest my husband as the instructor. Earl has a B.S. degree in Physics and expects to receive his masters degree in June at G.W. in Engineering Administration. He was a systems engineer for 2½ years, a technical writer for 7 years, and is now supervising writers. Personnel men tell us that the engineering-writing experienced men are rare, but as I have just indicated, there are some available.

Again, thank you for the article and, please, keep pushing the idea.

Sincerely,
Blanch Clifford

* * *

ACTION FROM ENGINEERS COUNCIL

Dear Sir:

As a senior in the G.W.U. S.E.A.S., I would like to see some action from the Engineers' Council of the S.E.A.S. In the past the E.C. has been a floundering body of nebulous responsibilities. However, the present Council has assumed more responsibility than others would allow and it must continue to expand its influence.

Engineering students are renowned for their apathy, and the engineering school has suffered greatly as a result. We have allowed the faculty of the S.E.A.S. to administer their whims and carry their laggers for too long. The students of the S.E.A.S. must realize that they have the right to at least be informed of policies which concern them and should have the right to help make them.

It is high time the Engineers' Council realize and demand this right.

James B. Bladen

LETTER TO THE EDITOR POLICY. The opinions set forth in the "Letter to the Editor" page of this magazine are not necessarily the opinions of the staff of *Mecheleciv* magazine. This page is set aside each issue for use by students, alumni, faculty, and staff of the School of Engineering and Applied Science. The staff will also accept letters from other sources if the letters concern the magazine or would be of interest to the students, alumni, faculty, and staff of the S.E.A.S. *Mecheleciv* reserves the right to edit any letter if lack of space deems it necessary. If, in the opinion of the Editorial Staff of *Mecheleciv*, a letter appears to be unprintable, the staff reserves the right to return the letter to the sender stating the staffs' reasons for withholding it from publication. All letters must be signed; however, pen names may be substituted if requested.

Campus News

DENNIS GALLINO AWARDED SCHOLARSHIP

Mr. Dennis Gallino, a senior Civil Engineer at the School of Engineering, was awarded a scholarship of $100. by the Professional Engineers Wives, an auxiliary of the D.C. Society of Professional Engineers.

Mrs. Alvin Meintz, President of the Professional Engineers Wives, said that Mr. Gallino was selected on basis of scholarship and interest in student and professional activities.

Mr. Gallino achieved the Dean's Honor List for Fall Semester 1966 and Spring Semester 1969. He expects to receive his BS degree in June 1970.

PROFESSOR TORIDIS RECEIVES GRANT

Dr. Theodore G. Toridis, Associate Professor of Engineering and Applied Science, was awarded a National Science Foundation Grant of $56,800 to support his research on "Local Buckling or Plasticity and the Ultimate Strength of Structures." The grant is effective for a period of two years.

This research will investigate the influence of local buckling of elements on the ultimate strength of framed structures. The method of approach used in the study will be based on the extension of finite elements to include the effects of plasticity in the presence of multiaxial stresses and of large deflections.

Both static and dynamic loading will be considered. In determining the plastic deformations of the structure, stress reversal and strain hardening effects will be taken into account by following through the history of deformations. The envisioned computer program will automatically indicate the failure of individual members based on practical plastic deformation limits or buckling criteria and modify the properties of the remaining structure for subsequent computations.

ENGINEERS' COUNCIL TO HOLD ELECTIONS

The Engineers' Council, a corporate body since 1937, will hold its annual elections on March 9-10, 1970. This year's election will include a direct election of the council officers. These include:

President–open to upper classmen only
Vice-President–open to upper classmen only
Treasurer
Secretary
Ass't. Secretary

Direct elections will also include: D.H. House Manager, Engineer's Week Chairman and Intramurals Chairman. Also two graduate-at-large representatives, one representative from each of next year's Soph., Junior and Senior classes. Petitioning will close Feb. 27, 1970. Further information can be obtained from either Bob Grant or George Mathews.

NEW CENTER TO HOUSE ENGINEER'S BALL

On Feb. 28, in the main ballroom of the recently completed multi-million dollar University Center, the Engineer's Council will sponsor the 87th annual Engineers' Ball. This affair, free to all engineering students both undergraduate and graduate, will top off the week of activities of National Engineer's Week and Engineers' Open House. Mark Litchfield, Engineer's Ball Chairman, will distribute invitations at spring registration. Be sure to pick up your invitations there or at Tompkins' 100 during the month of February.

Music will be provided by a nine piece band, *The Inventions.* An open bar and buffet table will satisfy everyone's needs. The highlight of the Ball will be the crowning of the 1970 Engineers' Queen who will be selected by balloting from candidates sponsored by various school groups. Success is anticipated by those who will attend, faculty and students alike.

FACULTY IN THE NEWS

Dr. Walter K. Kahn, who recently joined the faculty of the Department of Electrical Engineering, had the distinction of presenting two technical papers at the meeting and symposium jointly sponsored by the United States National Committee of the International Radio and Scientific Union, and Institute of Electrical and Electronics Engineers Group on Antennas and Propagation at the University of Texas, at Austin December 8-11, 1969.

Dr. Kahn's first paper, *Efficiency of a Radiating Element in Circular Cylindrical Arrays,* was presented at the USNC/URSI Session on Arrays. His second paper, which he co-authored with Dr. W. Wasylkiwskyj, of the Institute of Defense Analysis, *Scattering Properties and Mutual Coupling of Antennas with Prescribed Radiation Pattern,* was read at the IEEE G-AP Session on Electromagnetic Scattering.

Dr. Vallobh Vimolvanich of the Department of Electrical Engineering presented a paper at the 25th Annual National Electronics Conference, Chicago, Illinois, December 10, 1969. His paper, *Adaptive Systems and Pattern Recognition,* was also published in the Conference Proceedings.

Dr. Singpurwalla, Department of Engineering Administration, was invited to present a paper, *Life Tests,* at the Conference on Reliability in Electronics sponsored by the IEEE in London, England on December 10.

Dr. R.B. Heller, Department of Electrical Engineering, was invited to attend a conference on Digital Satellite Communication, sponsored by the IEEE in London, England, November 25-27, 1969.

Dr. Alfred M. Freudenthal, Technical Director of the Institute for the Study of Fatigue and Structural Reliability of the School of Engineering and Applied Science, has been invited to present the opening technical paper at the Air Force Conference on Fatigue and Fracture of Aircraft Structures and Materials.

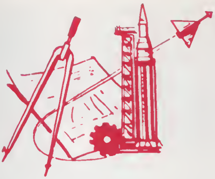
The Conference is under the sponsorship of the Air Force Flight Dynamics Laboratory and Air Force Materials Laboratory, Wright-Patterson Air Force Base, Ohio, which was held in Miami Beach, Florida, Dec. 15-18.

Some of the specific objectives of the Conference were: to review the state of aircraft structural fatigue analysis and testing procedures; to present recent advancements in materials development; to provide a review of applied fracture mechanics; to explore avenues for future research and development of materials and structures of improved performance.

Dean Harold Liebowitz has accepted invitations to serve on two ECPD (Engineers Council for Professional Development) teams to evaluate the engineering curricula of Ohio State University, Columbus, Ohio, December 8-9, 1969, and the School of Engineering at the Tennessee Technological University, Cookeville, Tennessee, January 12-13, 1970.

The ECPD conducts curricula evaluation for accreditation for the American Society for Engineering Education. The evaluating team is composed of representatives from universities, government, and business.

Accreditation identifies for parents and prospective students schools which meet acceptable standards of engineering education. It also gives assurance to the public and profession that the graduate's has been obtained in an institution meeting these standards. These evaluations frequently identify deficiencies and point to remedies which give guidance for planning by the institution.



Tech News

Edited by Gregory D. Smith, E.E., '72

SUBMARINE TANKER–General Dynamics has designed a nuclear-powered submarine tanker and proposed construction to several oil companies. Displacing over a quarter million tons when fully loaded, the submarine would traverse the Northwest Passage or the Arctic Ocean under the ice.

"OIL THROUGH THE NORTHWEST PASSAGE"

NEW YORK, N.Y., December 16 – General Dynamics announced today that it had made proposals to five oil companies to build nuclear-powered submarine tankers to move Alaskan oil under the ice to an ice-free North Atlantic port, where the oil would be transferred to conventional tankers for delivery to U.S. East Coast destinations.

The submarines could traverse the Northwest Passage or move under the ice of the Arctic Ocean to the open sea. They would be loaded either on the surface or while submerged off Alaska's Prudhoe Bay.

Roger Lewis, General Dynamics president, said that the proposals were made after extensive technical feasibility and cost evaluation studies showed the submarine to be an entirely practical and economically attractive means for moving arctic oil.

"Beyond the inherent reliability of nuclear power," Mr. Lewis said, "the arctic submarine, operating submerged, enjoys a steady 28-degree temperature and protection from ice, wind, waves and storms. In this constant and protected environment, the submarine is exposed to a minimum of environmental hazard. Navigation and schedule adherence can be precise."

Capable of carrying 170,000 tons of oil in its rectangular-shaped hull, the submarine would be 900 feet long, with a beam of 140 feet and a hull depth of 85 feet. Its twin screws would give it a speed of 18 knots.

"Our work shows the submarine tanker will achieve substantially lower costs for moving oil to the U.S. East Coast than those attributed to projected pipeline systems," Mr. Lewis said. "Comparison with possible icebreaking surface tanker costs is difficult," Mr. Lewis added, "because the oil moving costs of a surface ship system are dependent upon the ability of ships of reasonable cost to operate through the ice on schedule on a year-round basis at economic speeds."

"Several aspects of the submarine's inherent flexibility are of special interest," Mr. Lewis said. "Capable of being loaded either on the surface or while submerged, it can adjust its route as required to service possible new arctic oil discoveries and may be especially advantageous for moving oil from the Arctic Islands, should oil be found there."

"Reduced transportation costs are possible with bigger submarine tankers," Mr. Lewis said, "and our design provides that the main pressure hull and power plant of the 170,000-ton ship could be employed for ships up to 300,000 tons as larger shipbuilding facilities become available. The present ship has been sized to existing facilities," the General Dynamics executive concluded.

COMPUTER ON CALL: "Talking" to a computer from any standard telephone – even one in a roadside booth – will be a simple matter with an IBM portable terminal announced today. A salesman on the road, for example, could take the new IBM 2721 portable audio terminal into a telephone booth and enter orders directly into an IBM System/360 at his home office.

COMPUTER TERMINAL IN ATTACHE CASE

WHITE PLAINS, N.Y., January 26 . . . A portable terminal announced today by IBM will allow salesmen, insurance agents and others to "talk" to their home office computers from any standard telephone – even one in a roadside booth.

Built into an attache case, the new IBM 2721 portable audio terminal will rent for $20 a month. Users can enter alphabetic and numeric information into an IBM System/360 with audio response capabilities and get computer-compiled spoken responses to their inquiries.

"Many organizations, especially insurance firms and manufacturing companies, now store a variety of records in their computer files," vice-president Figueroa said. "With this new terminal, employees who need access to the information can get at it quickly and easily, even though they may know nothing about operating a computer."

For example, an insurance agent could carry the terminal to a prospect's home and telephone his firm's computer to help him prepare an estate plan. The handset of the telephone fits into the terminal's acoustic coupler, a cradle-like connecting device.

Using the unit's keyboard, the agent would then enter the prospect's age, income, number of dependents, present insurance coverage and other factors. The computer could then calculate the amount and type of protection needed to achieve the prospect's objectives.

The computer's reply is heard over the terminal's built-in speaker, or through an earphone. The spoken words are selected by the computer from a vocabulary stored in its audio response system.

Engineers and students could use the new terminal to solve mathematical problems. Department store clerks could verify a customer's credit, while bankers and stockbrokers could determine account and loan status and check stock quotations.

The terminal has 60 keys – 26 letters, 10 numerals and 24 special characters and controls. These can be adapted for specific applications with the use of plastic keyboard overlays.

If, for example, the terminal were used by a real estate firm to check new-home listings, a key might be labeled "2BR" to designate a two-bedroom home, and other keys could represent homes with other special features. This type of keyboard arrangement makes it easier for the individual user to recognize proper key positions.

The 2721 operates continuously for at least eight hours on rechargeable batteries, or can be plugged into any 110-volt AC line. The terminal measures 16 by 9 by 4 inches and weighs less than 10 pounds. It is supplied with an attache-style carrying case. The 2721 uses IBM's elastic diaphragm switch technology (EDST) – flat, pre-wired switches that eliminate mechanical key linkage. The absence of moving parts keeps maintenance requirements to a minimum.

NEW SYSTEM CUTS COST OF COMPUTER-ASSISTED MATHEMATICS INSTRUCTION

Computer-assisted mathematics instruction, already shown to be an effective way of giving students the individualized attention they need, is now available at a cost that appears low enough to take it out of the "experimental" category and into widespread use. Hewlett-Packard's new Computer-Assisted Instruction (CAI) System provides mathematics drill and practice for grades one through six at a cost of about $150,000 for a typical 32-terminal installation, compared with the million-dollar-and-up price of previously available systems. The program is one developed and validated at Stanford University.

The new HP/CAI System is a modified version of the HP 2000A Time-Shared Computer System. The mathematics instruction program has been written in the BASIC language, and the system treats it like any other time-shared

Thirty-two children use Hewlett-Packard's Low-Cost CA 1 System simultaneously. Ten-minute drills equal about one hour of in-class math practice.

program. For this reason, and because the CAI program uses only part of the computer system's capacity, any terminal that is not being used for mathematics instruction is available for general problem-solving. The convenience of conversational HP BASIC facilities is general usage by non-professional programmers.

Until now, CAI systems were always based on a large centrally located computer system, connected by telephone lines to teleprinter terminals at the schools. These large and complex systems are expensive to buy and costly to operate.

By contrast, the HP/CAI System is normally entirely located right at the school. To the student, the smaller system behaves exactly like the large central computers that are 3 to 10 times more expensive.

The HP/CAI Mathematics Drill and Practice Program provides six grades of curriculum for presentation by a teleprinter or equivalent. Each grade level contains 24 concept blocks of material. Each concept block contains 7 lessons (a pre-test, 5 main lessons, and a post-test). Each main lesson is available to the student at five levels of "difficulty." The computer selects the appropriate "difficulty" level, based on the individual student's performance. The student progresses at his own rate through the curriculum, receiving main lesson material and review material, based on his own past performance. The system maintains complete student records and produces a range of easily-used teacher reports.

OPEN HOUSE: FEB. 26, 27, 28

SCHOOL OF ENGINEERING AND APPLIED SCIENCE
THE GEORGE WASHINGTON UNIVERSITY
725 23RD ST. NW WASHINGTON, D. C. 20006

ENGINEERING

environmental design for the 1970's

national engineers week · feb 22-28

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STUDENTS!

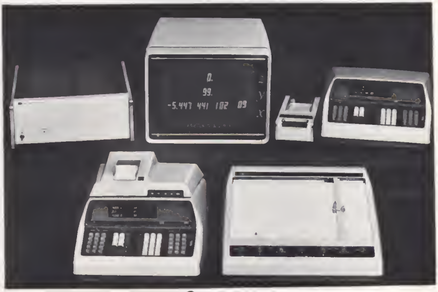
PARENTS!

ALUMNI!

The ninth annual Open House celebration of National Engineers' Week will take place the last three days of Engineers' Week this year. Many industrial and business concerns and government agencies will be participating and have provided a wide range of technical displays that will capture the interest of everyone. In addition, exciting laboratory experiments and demonstrations will be performed by students in our electrical and mechanical engineering laboratories. There will also be faculty, alumni, and students present to acquaint visitors with the Engineering Profession.

Some exhibits of particular interest will be a working model of a short distance transportation system from The Goodyear Tire and Rubber Company, a natural gas powered automobile from The Washington Gas Light Company, and a desk-top computer provided by Hewlett-Packard. The full list of exhibitors, to date, is shown below.

The School will be open to the public on Friday, February 26 and Thursday, February 27 from 9:00 to 5:00, and on Saturday, February 28 from 10:00 to 3:00. There will be guided tours and all are invited.



SUMMER INSTITUTE FOR BIOMEDICAL RESEARCH IN TECHNOLOGY UTILIZATION

By Kenneth F. Jacobs

The Summer Institute was a NASA experiment in technology transfer conducted at the Goddard Space Flight Center. Through the efforts of George Washington University, the program resulted in solutions of medical engineering problems and showed the effectiveness of the undergraduate engineering student in a research project.

TECHNOLOGY UTILIZATION PROGRAM

Outside of the Space Agency, the Technology Utilization (TU) Program is, unfortunately, less than commonly known and understood. It might do well to elaborate here to afford a clear picture of how the Summer Institute relates to, and serves the objectives of, this Program.

NASA's TU Program, which was established in the waning moments of 1962, is a unique program designed to transfer to the general public, in an active sense, the research and development results of a major technological organization. Every phase of the challenge of conquering the space environment has produced state-of-the-art innovations across the total spectrum of technology. That this information could have a meaningful impact on the technology base of this Nation has been dramatically demonstrated during the past seven years. Although numerous transfer cases have been documented during this time, the total effect this effort has had can only be speculated.

The task of transferring the benefits derived through the expenditure of public funds is by no means as easy as the concept is logical, and a great deal had to be learned. Nowhere was there a neat precedent, and the initial steps taken were to shape the program of today.

At each of NASA's Field Centers, there exists a Technology Utilization Office whose primary function is to retrieve, evaluate and assure the technical integrity of the new technology published and disseminated to the general public. There are essentially two sources of this information; in-house employees and contractors.

Working in cooperation with the TU Office, the GSFC Office of Patent Counsel makes available, for possible TU publication, all in-house innovations it receives for patent action. Once an invention is publicly disclosed, that disclosure constitutes a statutory bar, which means that there must be a patent application filed within one year from that disclosure date or no patent may be granted. Since TU publication does indeed constitute a statutory bar, close check is kept on each patentable item to assure prompt patent application.

All Research and Development contracts with NASA contain a "New Technology Clause." This clause insures that whatever inventions, innovations, new processes, concepts or ideas, developed under that contract must be reported to NASA for possible publication and dissemination. Accordingly, NASA takes title to all patents awarded for inventions resulting from the contract. However, there are exceptions where an item may be waived back to the company for marketing, as long as it is made available to the public in a reasonable time period. The Government retains royalty-free rights in such cases.

The number of new technology items, as one might suspect, are high, and so are the numbers of published items. Both are increasing due to a greater awareness by NASA employees and particularly NASA contractors of the public benefit the Technology Utilization Program has demonstrated. As a practical matter, the contractors are realizing that the position of the aerospace industry is strengthened due to the successes of such a transfer

program. The method of publishing this growing store of technology, therefore, must be simple and effective.

TU PUBLICATIONS

The primary vehicle for transmitting this information is the Tech Brief, one page abstracts of an individual innovation depicting the problem encountered and the solution. Usually, there is included a drawing or photograph to aid understanding. Tech Briefs are disseminated according to a mailing list, presently in excess of five thousand companies and individuals. These abstracts afford easy reading so that an individual may determine if he is interested in the technology presented. If he finds there exists a potential use for the information, he may acquire a complete disclosure of the item, called a Technical Support Package (TSP) from the originating Field Center. The appropriate address appears on the Brief. One may be placed on the Tech Brief mailing list by request to NASA Headquarters, Code UT, Washington, D.C. 20546, or the nearest Field Center Technology Utilization Office.

Also available are Special Publications (SP) which are the products of the TU Program. These documents are available through the Clearinghouse for Scientific and Technical Information which is under the Department of Commerce, and located in Springfield, Virginia. SP's include: *Compilations* which are collections of abstracted innovations in a particular subject category; *Surveys* which are in-depth studies into NASA's contributions to entire areas of technology; *Reports* which are comprehensive descriptions of individual innovations, or studies of a limited area of technology: *Bibliographies* and *Conference Proceedings.*

New approaches to this many-faceted problem of effectively transferring technology have been, and continue to be, tested.

BIOMEDICAL APPLICATION TEAM

Traditionally, the Program has rounded up innovative solutions to NASA's unique problems, and has made them generally available for application in other areas. This application is dependent on the initiative of the recipient. The TU Program has established the Biomedical Application Team program to markedly alter this process with regard to the medical profession. Briefly, under this concept, scientific teams interface with medical researchers to ascertain pressing technical problems. They then search NASA's vast store of technical information to determine if a solution exists. If this proves futile, the problem is made available through the TU Offices at the various NASA Field Centers to appropriate scientists and engineers for comments and suggested solutions.

This approach may prove to be impractical once outside a special interest area such as medicine, but the concept has shown sufficient merit to have prompted its application to the area of sociological problems.

Technology Application Teams are presently engaged in similar ways to solve problems in air and water pollution, fire fighting, law enforcement, and a host of other fields.

SUMMER INSTITUTE FOR BIOMEDICAL RESEARCH

The Summer Institute for Biomedical Research in Technology Utilization was proposed by the GSFC Technology Utilization Office as a unique method for technology transfer which could be used as a vehicle to accomplish a number of objectives.

The program was conducted at GSFC by the George Washington University's Dr. Marvin F. Eisenberg, School of Engineering and Applied Science, and also the Advisor to the Medical Engineering graduate program, and Richard C. Fowler, M.D., Medical Center, who also holds a degree in engineering.

"Group photo of those in the Summer Institute"

The ten student participants were selected by the University on the basis of an academic average of 3.0 or better, or on the specific recommendation of a faculty advisor. It was the intent of the program to include students with an exceptional problem-solving capability and an interest in medical technology.

Four universities were represented: George Washington, Maryland, Howard and Auburn.

THE PROBLEM AREAS AND PROJECTS

The students were paired into five teams and were assigned to five laboratories at GSFC to work for a

ten-week period toward the solution of their medical engineering projects.

These projects were defined by Drs. Eisenberg and Fowler from available problem abstracts submitted by the Biomedical Application Teams and selected because of their familiarity to the researchers at the GWU Medical Center. There were two main problem areas, (1) *The Ultrasonic Motion Detector* which was separated into two sub-projects, (a) *Transducers* and (b) *Electronics and Systems;* and (2) *The Activity and Environment Monitor* which was broken down into three sub-projects, (a) *Transducers and Telemetry,* (b) *Electronics and Systems,* (c) *Readout System.* **(A detailed description and explanation of these two devices along with a brief description of the five individual projects will be found in the Appendix at the end of the article.)

COURSE IN MEDICAL ENGINEERING ALSO GIVEN

This Summer Institute also included a three-credit graduate-level course entitled, *Introduction to Medicine for Engineers,* which was conducted at the GWU Medical Center two afternoons per week during the first five weeks of the Institute. The course was selected to expose the undergraduate engineers to the systems approach to physiology and not specifically to augment the research programs conducted at Goddard although the acquired knowledge appeared helpful. It was felt that this exposure would clearly indicate that more than a casual association between the medical and engineering fields is necessary.

During the first course session the five student teams selected a project from those available. The laboratory locations and the Goddard Technical Advisors were selected prior to the start of the Institute to assure the existence of expertise and facilities for each project. To assure the student participants' understanding of the medical considerations in the course of their research, two GWU graduate student "instructors" were utilized at GSFC on a full-time basis.

OBTAINMENT OF OBJECTIVES EXCEED EXPECTATIONS

The objectives set for this unique summer program were realistic and, it may be added, the attainment of most exceeded all expectations. These objectives and comments on the degree of success, based on observations and a post-program questionnaire, follow:

(1) *To provide an opportunity for the students to engage in meaningful research directed toward the solution of selected engineering problems in the biomedical field.*

There are very few summer programs available to undergraduate engineering students which afford an opportunity for them to engage in needed, meaningful work, particularly where the burden of responsibility for a project belongs exclusively to the student. The projects by their very nature were more than could be completed in a ten-week period, yet the teams produced prototype hardware. Admittedly, further refinement is required, but the approach of vesting full responsibility in the students paid dividends. They assumed a pride and commitment to accomplish these formidable tasks that would have been difficult to instill otherwise.

(2) *To foster interest in the field of medical engineering to bridge the ever-widening gap between the engineering and medical profession.*

The association between the medical and engineering professions should be more than a casual interface. The necessity of bridging these professions is increasing and one need only observe the degree of technological dependence of today's medical institutions. It is not felt that this summer's effort has sent ten engineering students scurrying off to save the medical world but rather a substantial awareness of the contributions an engineer might make in the medical field has resulted.

(3) *To generate a medium by which the existence and purposes of the NASA Technology Utilization Program can be communicated to a number of engineering colleges.*

This objective, according to the students' response via questionnaires, has been met, although to what extent remains to be ascertained. Using NASA technology as an information base for future engineers, who have yet to

impact private industry or public service agencies, is an effective means of transfer.

(4) *To provide students with an appreciation for the variety and sophistication of technology developed by NASA scientists and engineers.*

This was an objective that required no concerted effort to attain. A ten-week association in the laboratories of GSFC, it was reasoned, would assure this attainment. More importantly, it provided the students with a firsthand look at the source of the technology published through the TU Program, which could only increase their acceptance of this method of technology transfer. Through informal discussions it was noted that not only were they impressed with the sophisticated technology, but also with the utilization it has realized elsewhere, particularly in the medical field.

(5) *To provide students with an awareness of the career opportunities available in scientific and engineering work within NASA.*

No concerted effort was required to attain this objective. In those questionnaires received after the program, each indicated interest in working at GSFC.

(6) *To evaluate the potential of the Summer Program in achieving the above objectives so that consideration can be given to adoption of similar Institutes at other NASA Centers.*

The evaluation is still in progress. The concept has the possibility of opening a new arena of association between the Technology Utilization Program and the educational community including both medical and engineering institutions.

CONCLUSIONS

The Summer Institute, in conclusion, has demonstrated, in addition to those benefits discussed above, a realistic need for the inclusion of practical engineering experience for undergraduate students. Short of attending a "Co-op" institution, meaningful, practical experience at the undergraduate level is apparently almost non-existent.

The participating students all agreed that more should be done in this area by both government agencies and universities. The extent to which this experience has been of benefit to them has been significant, particularly since they have one year of academics remaining. The knowledge and experience gained can place further studies in their proper perspective. Furthermore, this Summer Institute has demonstrated that undergraduate engineering students, given the opportunity and responsibility, are able to make significant contributions. They are indeed an untapped, valuable resource.

APPENDIX

PHYSIOLOGICAL ACTIVITY AND ENVIRONMENT MONITOR

The activity and environment monitor is being developed to fill the need for an easy to operate, unobtrusive and relatively inexpensive system which will monitor and record, for up to 24 hours, various physiological and environmental parameters such as heart rate, footsteps, accelerations, noise level, light level, temperature, humidity, etc. It is designed to be used by the patient in his home environment rather than under controlled conditions.

The input to the basic system consists of a series of pulses which represent the value of the parameter to be recorded. These impulses which originate in the input transducer are fed into a very low power digital binary counter for a given time interval such as one minute. At the end of this time interval the total number of stored pulses, giving a one minute average, is recorded on magnetic tape in a much shorter time such as two seconds. This provides a tape expansion ratio of thirty to one. Thus a one hour tape cartridge can record thirty hours of data. Four tracks can be recorded simultaneously on a standard cartridge. In addition, by using multiplexing techniques, a number of parameters can be recorded on each track. The system therefore has the capability of recording a considerable number of parameters for at least 24 hours. By reducing the total running time, additional parameters can be recorded at shorter intervals.

The complete system therefore consists of transducers, communication links, which can be either wire or telemetry, from the transducer to the central system, the digital and control electronics, the tape recorder and the readout unit.

The immediate goal for the Summer Institute is to develop two transducers, the communication links, the digital and control electronics for one channel, modify a one channel commercial small tape recorder and develop the readout unit which converts the recorded information to a paper recording.

PROJECT 1–ELECTRONICS AND SYSTEMS

This section consists primarily of a very low power digital binary counter, a low power timing and control system and a small, relatively inexpensive commercial tape recorder. This group will develop the electronic system and


CAVU*

modify the tape recorder. The unit will be packaged so as to make a compact, rugged usable system.

PROJECT 2–READOUT SYSTEM

This group will design and construct a complete readout system. Its function will be to take the sequence of pulses representing each data entry on magnetic tape and convert the number of pulses to an analog voltage. This voltage will then be recorded on paper using a conventional strip chart recorder. The end result for a complete run should consist of a paper recording of amplitudes, of each data point, plotted against time. This unit involves some unique timing problems which will have to be solved by this group.

PROJECT 3–TRANSDUCERS AND TELEMETRY

This group is involved in the development of various simple to use and inexpensive transducers which will provide the input to the digital counter. Two possible ones are heart rate and footsteps, both measured in counts per minute. In addition, a low power telemetry system, having a reliable range of approximately 6 feet, will be developed to transmit these impulses to the central unit.

ULTRASONIC MOTION DETECTION

The non-destructive and non-perturbative testing of an individual is the goal in most clinical measurements. Modern technology permits the use of ultrasonic methods to be employed which fulfill these criteria. In particular, anatomical structures may be "visualized" as a consequence of differences in acoustic densities producing multiple reflections. Depending upon the mode of operation, static structures or motion may be demonstrated and presented in a variety of ways.

The CW doppler ultrasonic system operates by transmitting a continuous signal into the body. A reflected signal is received from each interface which the signal encounters. If the reflecting surface is moving, such as the wall of an artery, there will be a shift in the frequency of the reflected signal. This shift in frequency will be proportional to the velocity of the moving surface. This method tends to eliminate the effects of the stationary interfaces.

This technique has been used in the peripheral vascular clinic of The George Washington University Hospital for the detection of blood flow in patients with peripheral vascular disease. These patients generally have greatly decreased blood flow in the extremities resulting in a pulse so weak that it cannot be detected or only poorly detected by palpation. The results of this work indicate that in many cases where the pulse is not palpable it can be detected using a CW ultrasonic doppler instrument. This same instrument is also being used for the detection of heart and valve motion as well as in various other areas involving motion of structures within the body.

There exists a need for an instrument which is relatively compact, inexpensive and simple to use. This project consists of a thorough study, both theoretical and experimental, of the principles involved, an initial design including a breadboard model, a final design, construction of a complete unit and testing and evaluation of this unit.

Two groups will be working on this project. Both will be concerned with the study of principles. One group will work on the transducers as well as the design and construction of an artificial artery. The other group will work on electronics and systems.

PROJECT 4–TRANSDUCERS

This group will first investigate both theoretically and experimentally the principals involved in the CW ultrasonic doppler. They will determine the optimum electronics configuration including the detector circuit or circuits which will result in the best overall functioning of the instrument.

The transmitting and receiving ultrasonic transducers can be constructed using various fabrication techniques, configurations and materials. They will attempt to find the optimum balance between function and cost in keeping with the goal of producing a well functioning economical instrument rather than a "perfect" one.

This group will then design and construct transducers for use in the complete instrument.

PROJECT 5–ELECTRONICS AND SYSTEMS

This group will investigate both theoretically and experimentally the principles involved in the CW ultrasonic doppler. They will determine the optimum electronics configuration including the detector circuit or circuits

which will result in the best overall functioning of the instrument.

They will breadboard and evaluate the system using available instruments where possible. Based on this data a final system will be designed, constructed and evaluated. A key factor in this final design will be the cost of the unit in production quantities.

"Mr. Kenneth F. Jacobs"

Born in Lawrence, Massachusetts in 1940. Attended Lowell Technological Institute, Lowell, Massachusetts, receiving a B.S. degree in Mechanical Engineering and a commission in the USAF in 1962. In senior year, held the office of President of the Vandenberg Air Society, an honorary society of the ROTC program.

Military Service in the Air Force Logistics Command (AFLC) at Kelly AFB, Texas included design of air conditioning units for the Base Civil Engineering organization, as well as being the sole military member of the Base Civil Engineer Data Automation Task Group. The 5-man team was charged with laying the groundwork for an ADP system to cope with the voluminous data necessary for housekeeping Air Force Bases.

Member of the Society of American Military Engineers and the San Antonio Air Materiel Area (SAAMA) Junior Officers' Advisory Council. Held office of President and Vice President of the Advisory Council.

Upon termination of active duty in 1965, gained employment with the Meter Department of the General Electric Company in Somersworth, New Hampshire as a Production Engineer responsible for all dial presentation demand registers and time-switches.

Accepted a position in the Goddard Space Flight Center Technology Utilization Office in 1967. This position afforded an opportunity of entering the administrative field while maintaining close engineering association.

Gained appointment to the position of Technology Utilization Officer in April of this year. Responsibility of the office was assumed in an "acting" capacity in August of 1968.

MARS

REVISITED . . . TWICE

THE STORY OF MARINER/MARS 1970

By David R. Armstrong

Editor-in-chief

This past August, the United States revisited Mars with the successful dual fly-bys of the Mariner 6 and Mariner 7 spacecraft. These spacecraft revealed Mars to be heavily cratered, bleak, cold, dry, nearly airless and generally hostile to any Earth-style life forms. Mariner 7 performed its mission objectives perfectly despite being damaged, possibly from a meteoroid impact, during the final week of its Earth-to-Mars journey.

The Mariners were developed and their missions conducted for the National Aeronautics and Space Administration by the Jet Propulsion Laboratory in Pasadena, California. The mission objectives of the Mariner Mars 1969 Project were to study the Martian surface and atmosphere to establish the basis for future experiments in the search for extra-terrestrial life and to develop technology for future Mars missions. The question of whether or not life is present, or did at any time exist, may be answered by these future expeditions.

Arriving five days apart, the two instrument-laden spacecraft sampled the Martian atmosphere for temperature, pressure and chemical constituency. Surface temperatures also were measured in an effort to correlate thermal characteristics with features observed in the TV pictures. Mariner 6 examined at close range the equatorial regions of Mars, primarily the near-equator latitudes of the Southern Hemisphere. Mariner 7 covered some of the same area, but concentrated on the Southern Hemisphere, the South Polar Cap and the Pole itself. Both spacecraft took a number of long range looks at the planet with telescope-equipped TV cameras.

The encounter phase of each flight was divided into two distinct phases – far encounter, in which full disc TV pictures of Mars were obtained, and near encounter, when the full complement of scientific instruments scanned Mars from close range.

Commands to activate the Mariner 6 scientific instruments were transmitted from the Goldstone station in the Mojave Desert on the evening of July 28. The spacecraft's scan patform was pointed at Mars so that a light sensitive sensor would track the planet's center of brightness to keep the TV camera pointed accurately at Mars.

Mariner 6 took the first of 50 approach pictures at 1:26 A.M. EDT on July 29 from a distance of 771,500 miles. Although the camera took a picture each 84 seconds, only one picture each 37 minutes was recorded on the spacecraft's analog tape recorder. (A second TV camera also was operating – alternately with the first – but its pictures were recorded only during the close passage.)

Nearly 20 hours later, a full tape load of 33 pictures had been recorded. They were played back to Earth – one each five minutes beginning at 9:35 P.M. EDT – and received at JPL via the Goldstone station.

TV TRANSMITTING AND RECEIVING SYSTEMS

A new high-rate telemetry system – 16,200 bits per second – on the Mariners and the use of the 210-foot-diameter antenna at Goldstone allowed the acquisition of the large number of approach pictures. Mariner 6 took 50 such pictures, in segments of 33 and 17, providing full planet pictures during two revolutions of Mars.

From August 2 to August 4, Mariner 7 took 93 far encounter pictures, recording the changing view of Mars during three planet revolutions. These were taken in increments of 34, 34, and 25.

The second tape-load of Mariner 6 pictures, taken on July 30, included a two-picture attempt to photograph one of Mars' two moons, Phobos. Pictures #40 and 41 were timed two minutes apart to "capture" Phobos as the tiny moon rose on the eastern limb a few degrees above the Martian equator. Phobos was not apparent in the raw picture data. Further picture enhancement may reveal its presence.

All 200 TV pictures received from the two Mariners were displayed on television monitors at JPL as they were received from the spacecraft. This was made possible by the high-rate telemetry system, the 210-foot antenna, a microwave link from Goldstone and specialty equipment at JPL.

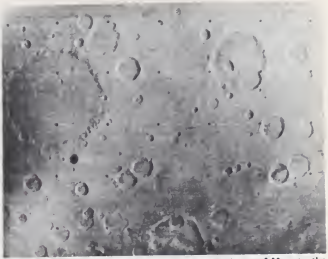
Each five minutes during the playback session, a new picture containing more than half-a-million picture elements was seen on the monitors. Seven playback sessions contained a total of more than 17 hours of real-time TV display.

In addition to the 200 pictures stored on the analog recorder and played back, Mariner 6 and 7 transmitted to Earth 1177 digital pictures as they were taken every 42 seconds by the cameras. The digital pictures contained every seventh picture element of each picture line and are used for photometric measurements.

NEAR ENCOUNTER

The Mariners began their near encounter sequences 35 minutes before closest approach with the cryogenic cool-down of one of the scientific instruments – the infrared spectrometer. At encounter minus about 15 minutes, the two TV cameras – shuttering alternately every 42 seconds – the infrared spectrometer, infrared radiometer and ultraviolet spectrometer began taking planetary data, some of which was transmitted directly to Earth and all of which was recorded on board the spacecraft.

This far encounter picture shows a remarkable webbed network of light lines in the Thaisis and Arcadia regions (upper left portion of the planet). That structure has not been seen from Earth before.



This near encounter picture shows the resemblance of Mars to the Moon. The cratered surface of Mars in this photo was roughly 560 by 430 miles. This photo, taken at an altitude of 2,150 miles, records roughly 100 craters. The largest crater visible is about 160 miles in diameter.

Mariner 6 kept its rendezvous with Mars at 1:19 A.M. EDT on July 31, passing within 2130.2 miles of the planet's surface after a 241 million-mile flight in 156 days.

Mariner 7 made a close passage by Mars on August 5, closing to an altitude of 2130.2 miles at 1:01 A.M. EDT. Total Earth-to-Mars elapsed time and miles clocked were 130 days and 197 million miles.

Mariner 6 took 24 near-encounter pictures – 12 high resolution and 12 medium resolution – during a 17 minute period. It reached its nearest proximity to Mars during the last few minutes of the close-up TV sequence.

Mariner 7 took 33 near-encounter pictures – 16 high resolution and 17 medium resolution.

The scan platforms on both spacecraft were slewed twice during the Mars passage, resulting in a three-segment trace across the planet. The Mariner 7 scan program had been revised on the basis of the Mariner 6 data to provide maximum coverage of the South Polar Cap.

When the TV swath of overlapping and nested pictures crossed the day/night terminator, picture recording ceased. The other instruments continued taking and recording dark-side data out to and beyond the limb of Mars about 10 minutes after closest approach.

All instruments aboard Mariner 7 functioned perfectly. On Mariner 6, one of the infrared spectrometer's two channels did not get cold enough to operate.

MARINER 7 STRUCK BY METEOROID

On July 30, just seven hours before Mariner 6 was to

Photo 6N7 is a wide-angle TV picture taken by Mariner 6 and shows an area of about 600 by 940 miles. Photos 6N8, 6N6, and /N14 (all narrow angle photos) show two types of terrain: a relatively smooth cratered surface giving way abruptly to irregularly-shaped apparently lower areas of chaotically jumbled ridges.

cross the orbit of Mars, the radio signal from Mariner 7 fell silent. The Deep Space Station at Johannesburg reported loss of signal at 6:11 PM EDT. It was believed, and the cause is still uncertain, that Mariner 7 may have been struck by a meteoroid.

One of the Deep Space network's two Madrid stations was tracking Mariner 6. The other broke off tracking Pioneer 8 and joined the search for Mariner 7. As the Earth turned under the spacecraft and Mariner 6 neared Mars, three Goldstone stations came into view. The Pioneer Station at Goldstone picked up a very faint signal about 1:30 A.M. EDT on July 31, just a few minutes after Mariner 6 whipped by Mars. Commands were transmitted to Mariner 7 to switch antennas and 11 minutes later – round trip light time between Earth and Mariner 7 – a healthy signal was detected by stations at Goldstone and in Australia.

It was learned that Mariner 7 had lost lock with its celestial reference, the star Canopus. Hence, the high gain antenna no longer pointed at Earth. Canopus lock was re-established and further tracking indicated Mariner 7 had been damaged, including the loss of some 20 to 90 telemetry channels.

Mariner 7 also had changed velocity. It apparently was receiving a small amount of thrust, possibly from an outgassing pressure vessel. The measured continuing acceleration of a few millimeters per second changed the spacecraft trajectory slightly, causing it to arrive 10 seconds later than predicted but very close to the predicted altitude.

Following occultation, the near-encounter scientific data recorded on two tape recorders – one analog, one digital – aboard each Mariner was played back. The digital recorder, which stored all near encounter data, including TV, was played back at the normal scientific rate, 270 bits per

second. At about 19 hours after closest approach for both Mariners, the digital playback was interrupted for a five-hour playback of the analog recorder (TV near encounter only) at the high rate, 16,200 bits per second.

By mid-August both spacecraft had played back all the scientific data several times. The two Mariners remain in their solar orbits and are tracked periodically by stations of the Deep Space Network.

Two experiments which required no special instrumentation were conducted by Mariner 6 and 7. One was occultation which provided atmospheric pressure measurements through the analysis of changes in the spacecraft radio signal as the spacecraft disappeared behind Mars relative to Earth.

Tracking data obtained throughout encounter, as well as during the entire flights, contributed to the celestial mechanics experiment.

EXPERIMENTAL PACKAGES

The Mariner spacecraft carried several scientific equipment packages. These included the T.V. Experiment, the Ultraviolet Spectrometer, the Infrared Spectrometer, the Infrared Radiometer, the S-Band Occultation Experiment, and the Celestial Mechanics Experiment.

The Television Experiment was designed to photograph the disc of Mars as the planet revolved through several Martian days and take high resolution pictures of the surface during the close approach. The Ultraviolet Spectrometer analyzed the composition of the upper atmosphere of Mars while the Infrared Spectrometer analyzed the composition of the lower Martian atmosphere. The Infrared Radiometer made Mars surface temperature measurements, and the S-Band Occultation Experiment determined the pressure and the density of the Martian atmosphere. The Celestial Mechanics Experiment provided data for the continuing effort to refine astronomical values.

PRELIMINARY SCIENTIFIC RESULTS

TELEVISION: The principal results from preliminary study of the Mariner 6 pictures are: the surface of Mars appears similar to that of the moon, but there are significant differences; some features seen from the Earth are characterized; the "blue haze" hypothesis is disproved; and new phenomena with the polar cap are discovered.

Highlights of initial study of the Mariner 7 pictures, in addition to confirming the first reported results of Mariner 6, are; additional physiographic interpretations of classically observed features are made; the surface of the south polar cap is generally visible and many large topographic configurations, but "snow-free" areas are apparent within the polar region; and the Hellas region appears devoid of craters, thus implying the operation of more effective, more recent, and more geographically confined surface processes than heretofore evidenced.

ULTRAVIOLET SPECTROMETER: As the Mariner 6 UV spectrometer viewed the brightly illuminated limb of Mars, ultraviolet emissions were measured which showed atomic hydrogen and atomic oxygen are present in the upper atmosphere. Additional measurements of the ultraviolet light from the limb showed the emission spectrum of expected constituents of the Martian atmosphere, carbon dioxide and carbon monoxide. The initial study of the data has shown that the very important molecule nitrogen was not present. If additional intensive analysis substantiates this conclusion, a very key chemical compound is missing from the Martian environment. If this is true, any life chemistry on Mars will have to be very much different than we know on Earth.

The Mariner 7 UV spectrometer successfully measured the composition of the upper atmosphere on two passes over the limb of the planet and confirmed the results of Mariner 6 in finding no molecular nitrogen in the upper atmosphere. The new result associated with Mariner 7 comes from the pass over the polar cap. The intensity of the ultraviolet light from the planet increased abruptly as the spectrometer view passed from the desert onto the polar cap showing that ultraviolet radiation at very short wavelengths penetrates to the surface of the planet. This result shows that the planet is bathed in this energetic solar radiation.

INFRARED SPECTROMETER: The Mariner 6 IR spectrometer successfully recorded data in the spectral region 2 to 6 microns. With 60 by 60 mile spatial resolution, significant thermal variations were detected, revealing temperatures up to 75°F. The data also revealed the local reflectivity of solar light and it is clear that the darker spots on Mars are warmer than the bright areas. The carbon dioxide intensity reveals topographical detail that remains to be analyzed. Neither ammonia nor nitric oxide was evident, however, carbon monoxide was detected. Perhaps the most exciting result is that the spectrum of ice was recorded. It seems unlikely that this ice could be in the spectrometer — the only possible misinterpretation — and the experimenters tentatively attribute it to a very thin ice fog. Finally, there are two or three uncertain spectral features that remain to be verified and identified.

The Mariner 7 IRS experiment produced data from both channels. These data were first believed to have contained evidence of gaseous methane and ammonia, and the suggestion that a portion of the polar cap is composed of ice. Further analysis of the data is required before a firm conclusion can be reached.

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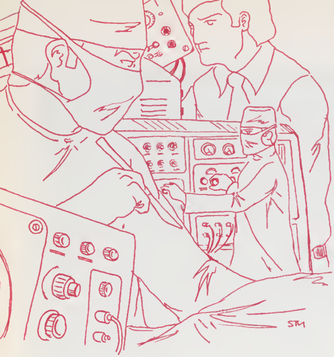


MEDICAL ENGINEERING

MEDICAL CYBERNETICS

Edited by Jorge Aunon

Norbert Wiener, the famous mathematician, defined cybernetics as "the science of control and communication in the animal and machine" (Wiener, 1961). The term "cybernetics" comes from the Greek word "Kybernetes," which means steersman. Control, or the art of controlling, is implied by the word.

Problems of control occupy an important place in various sciences. The obvious disciplines of automatic control processes, optimal control, etc.... provide an evident example. Other sciences, like physiology, study the control processes in living organisms. Sociology, likewise, investigates the control processes in society.

Once the different control processes become better understood, the possibility exists of their description with the same mathematical formulation. Mathematical disciplines are, therefore, the foundation of cybernetics. The quantitative evaluation of any process or system, no matter how simple or complex it may be, characterizes the cybernetic approach to the investigation of the surrounding world.

SYSTEMS

Cybernetics is concerned with general laws of control, control systems, and systems that are controlled. For example, in physiology we study the cardiovascular system, a subsystem of which would be the circulatory system; the solar system is an astronomical system, and a complex DNA molecule is a system which consists of submolecular elements.

Systems may be either deterministic or probabilistic. *Deterministic* systems are always predictable, being always possible to predict the following states of the system on the basis of its preceding states. *Probabilistic* systems, on the other hand, can only be predicted with a certain amount of probability; the greater the probability, the better known the mechanisms of the interactions of its elements. A flashlight is a deterministic system (provided the batteries are not dead), whereas a cat may be considered a very complex probabilistic system. If we have a new battery in the flashlight, by turning the switch to the "on" position, light will result. A cat, however, does not act like that; when offered milk, there is a high probability that it will be accepted, but there is also the probability of rejection. Cybernetics is interested in fundamental probabilistic systems, although deterministic systems are frequencly utilized as models.

We may consider the science of cybernetics to be divided into three groups:

(1) theoretical cybernetics, which studies problems related to the common mathematical description of control processes;

(2) engineering cybernetics, which is concerned with the engineering problems involved in creating control systems and other types of information systems;

(3) applied cybernetics, which is involved with the problems of applying cybernetic concepts to various areas of human activity, including medicine.

MEDICAL CYBERNETICS

Medical cybernetics is a division of applied cybernetics which utilizes the concepts and achievements of cybernetics to deepen medical knowledge, improve the quality of medical service, and increase the effectiveness of the scientific and practical work of physicians. Man is the main

objective of medical cybernetics. Research on animals and other living systems is a task of biological cybernetics, which is the theoretical basis of medical cybernetics.

The problems with which medical cybernetics is concerned can be divided into three groups:

(1) diagnostic problems;

(2) problems related to the automation of patient services and the creation of automatic devices for medical purposes;

(3) problems of the application of cybernetics in specific fields of medicine, e.g., surgery, radiology.

Examples of the above could be multiphasic screening clinics, automated patient monitoring, etc.

THE DIAGNOSTIC PROCESS AND CYBERNETICS

Diagnosis is a process that begins with the collection of information from a patient. This information is analyzed, reviewed and stored. The results of the analysis of information are then converted into therapeutic actions, thereby closing the loop with the patient. Thus, it can be concluded that diagnosis is a typical cybernetic process associated with the collection, transmission, storage, and processing of information. *Figure 1* is a diagram of this process. Note that there is feedback between the "collection of information" stage and the "analysis" and "review" stage. This is necessary to check on the quality of the information being collected.

Information

Information on the patient is collected in accordance with an examination plan. The examination begins with standard questions (what hurts?) and standard tests (temperature, pulse rate). It is collected by various instruments (electrocardiographs, x-ray machines, thermometers), by medical personnel and by the physician himself. In the last few years, there has been a rapid growth of information collection means. New research methods, transducers, and instruments for examining patients and making diagnoses are being developed. Multiphasic screening clinics are a good example of the above.

Figure 1 shows a certain amount of "noise" affecting the "collection of information" stage. This noise or interference results from the collection and processing of excessive or redundant information which is useless to a diagnostic process. This type of interference decreases the quality of a diagnosis and increases the information circulation time.

Analysis

Analysis is the stage of a diagnostic process which is associated with the preparation of collected information for logical or mathematical evaluation, the results of which, after physician interaction, is the "diagnosis."

Continued on Page 35

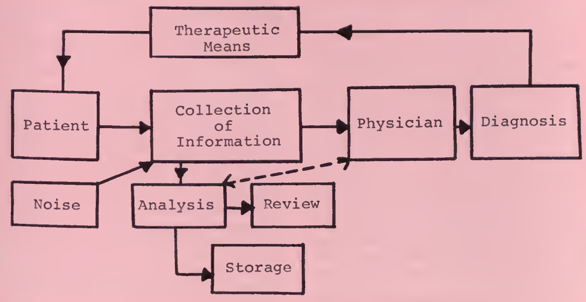


Figure 1

THE APOLLO TELEVISION

Edited By

Sidney J. Harmon, II

Since the television pictures in the last five Apollo flights were beamed around the world and were seen by millions of people, the cameras used to produce those pictures have become one of the best known items of equipment in the program.

The black and white television cameras used within the spacecraft during Apollo 9 and on the moon's surface during Apollo 11 and 12, and the color cameras used within the spacecraft during Apollo 10, 11, and 12 were all designed and built for the NASA Manned Spacecraft Center by the Westinghouse Aerospace Division.

The color cameras were both returned to earth while the black and white lunar camera was left mounted on its tripod on the moon.

One of the color cameras that was returned, the Apollo 10 unit, was modified for NASA by the Westinghouse division for use on the lunar surface during Apollo 12.

The steps taken to update the lunar color camera were primarily improvements in its thermal characteristics. Excessive heat buildup or heat differential inside an electronic unit like a television camera can, of course, lead to damaged components.

The power reduction in turn reduced the amount of heat generated in the camera. The outside of the camera was coated with the same material used on top of the Apollo 11 lunar camera. This coating has high thermal emissivity (heat loss from the camera) and low thermal absorptivity (heat absorption due to the sun's radiant heating effect). In addition, the material resists changes due to ultraviolet radiation.

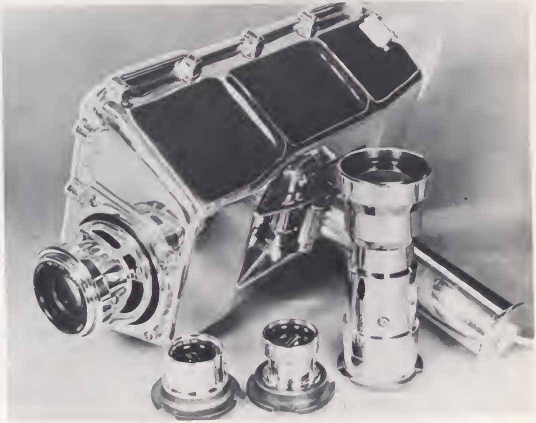
Other changes made in the camera were the color shell motor and gearing to reduce power consumption from 20 to 15 watts and to insure stability of operation in the vacuum environment.

The black and white and color cameras are all small enough to be hand held. They have the sensitivity and automatic control necessary to consistently produce good pictures over a wide range of light levels and scene content.

During the Apollo 10, 11, and 12 flights, color cameras provided real-time color scenes of the earth, the moon, spacecraft maneuvers and spacecraft interior scenes. These color cameras were built for use only in the spacecraft environment. They were used in conjunction with a miniature television monitor, also built by Westinghouse, in the command module to help aim and focus the camera.

The black and white lunar TV camera, pictured, was designed and built for the vacuum and extreme thermal conditions found on the moon's surface. In the moon landing, the camera was stowed in the descent stage of the lunar module. As Astronaut Armstrong descended the

CAMERAS



ladder for the first moon walk, he pulled a lanyard which opened the compartment door on which the camera was mounted. When the door opened, the camera pointed at the lunar module ladder and showed the astronaut's first steps on the moon.

After Armstrong's preliminary work such as gathering the contingency samples, he set the television camera on a tripod some thirty feet from the lunar module. The camera televised the activities of the astronauts until they re-entered the lunar module. After jettisoning the equipment they no longer needed, the astronauts switched from a frequency-modulation to a pulse-modulation mode of transmission from the lunar module which took the camera off the air. Television pictures could only be transmitted in the frequency-modulation mode.

As with all television cameras, the important part of the Apollo cameras is the image tube. Both the color and black and white cameras are equipped with a low-light-level tube, the SEC (secondary electron conduction) camera tube.

The SEC camera tube has been recognized for some time as being ideally suited for space applications because of its size, weight, power requirements, ruggedness, stability, and simplicity of operation. It has wide dynamic range, tolerance to high saturation levels, and an electrical gain mechanism. The two latter features are necessary for a portable camera, such as the Apollo cameras, with little or no operational control to handle changing or uncontrolled scene lighting.

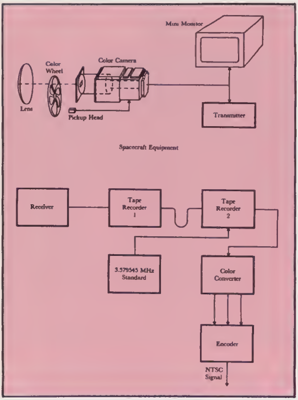
APOLLO BLACK AND WHITE LUNAR CAMERA

In several respects, the black and white camera is unique among the rest of the Apollo electronics equipment. It is one of the few items required to operate under all phases of mission environment from launch pad to the moon, on the moon's surface, and back to earth. More than 80 percent of its circuitry is in the form of molecular integrated devices. Today's most advanced sensor tube, the SEC camera tube, enabled the camera to operate under the low-light-level conditions encountered during the lunar landing.

The main mission of the camera was to provide real-time television pictures of phases of the Apollo mission.

To conserve transmission bandwidth, the scanning rate for the lunar camera was slower than those of standard broadcast television. When received on earth, the pictures were converted to broadcast television rates for retransmission by commercial stations.

Mission environments and compatibility with other equipment placed numerous constraints on the camera



GROUND EQUIPMENT

FIGURE 1

design. As with all space equipment, highly reliable operation was a prime requirement.

Environmental conditions that the camera had to withstand were: vibration of 10 to 2000 cycles per second (up to 6 g) and shocks of more than 8 g during Apollo launch and lunar landing; pressure variation from sea level to 10^{-14} mm Hg; temperature extremes on the moon's surface from +250 degrees F during the lunar day to -300 degrees F at night; acoustical noise of 130 dB (above 0.0002 dynes/cm^2).

In a spacesuit, an astronaut's dexterity is reduced. Ease of handling, holding, pointing, changing lenses, connecting and disconnecting, and storing placed many constraints on the design of the camera package. The final design of the camera left only two operations to the astronauts: changing lenses and switching scan modes. All other controls are automatic within the camera. Since the camera was to be hand held, it had to be small and lightweight.

Predicted scenes included views of astronauts on the moon, the lunar surface, and the lunar module on the moon. Light levels for just these scenes varied from partial earthshine on the moon to full sunlight, a range of 0.007 to 12,600 footlamberts.

Scanning parameters for the camera were selected by NASA to best fulfill the over-all mission. Several factors influenced the selection of the scan rates.

Motion rendition had to be preserved to avoid break up in pictures. Ten frames per second provide acceptable motion rendition. Although some motion break up could occur in normal scenes, the motion rendition during the Apollo 11 mission was satisfactory.

Ease of scan conversion to the standard rate of 60 frames per second (fps) was another factor in determining the lunar camera frame rate, since submultiples of 60 fps are most easily scan converted. Bandwidth and power for television transmission were severely limited. Since the camera had to share bandwidth with voice, biomedical, and other telemetry data, the camera was limited to a 500-kHz bandwidth.

A 320-line scan was chosen to obtain nearly equal horizontal and vertical resolution. Most home television sets reproduce about 300 TV lines from a 525-line scan and provide a pleasing picture. The 10-fps mode provided a picture of about 250 discernible lines which provides a satisfactory picture.

Video from the camera was sent over a 100-foot cable to the lunar module transmitter. Camera video was mixed with the voice sub-carrier and telemetry prior to insertion into the transmitter. The S-band transmitter provides approximately 12 watts to the steerable antenna. Use of this antenna provided good signal-to-noise ratio reception on earth.

Earthbound receiving stations are located at Goldstone, California, Madrid, Spain, and Canberra, Australia. Each of these stations has a high-gain antenna and scan conversion equipment. Received video is separated from the carrier and must be converted to standard TV rates before it can be sent to commercial stations.

Scan conversion is accomplished through the use of a cathode ray tube, a vidicon camera, a disc recorder and a video encoder. A vidicon camera views the cathode ray tube which displays the 10-frame video. The camera operates at standard 30-frame rate but will read out only one field each time it is keyed. Each frame of the lunar camera video takes 100 milliseconds which is equivalent to six fields of standard television frame time. Fifteen milliseconds before the end of one frame on the cathode ray tube, the vidicon camera is keyed to scan one field. This allows it to be read out and ready to receive new information by the end of both scans.

This video is recorded on a magnetic disc recorder. Six fields of this video are read out of the recorder to provide three frames of standard rate signals. Every other field is delayed by one-half line time to simulate interlace. Correct sync is inserted into the video to provide the correct format for broadcasting. When converted in this manner, the 10-frame flicker is no longer present.

Several lenses were required for different fields of view and the light level was expected to vary from 0.007 to 12,600 footlamberts. To cover both of these conditions, a

"The Apollo Color Camera (Westinghouse)"

set of four fixed-focus lenses were chosen in preference to a zoom lens or a turret system, because either of the latter would have been heavier and less reliable.

The lenses are all a quick-disconnect type that can be changed by an astronaut in a spacesuit. T-numbers (A T-number is the combination of f-number and effects of filtering) were chosen so that the photocathode illumination would be within the dynamic range of the camera tube for the various scenes.

Maintaining optical focus for all lenses under all environmental conditions required careful selection of mounting materials and methods. For example, the lenses are mounted directly to the tube assembly rather than to the camera case. This permitted closer mounting tolerances to be maintained.

APOLLO COLOR CAMERAS

The cameras generate a field sequential color signal using a single image tube and a rotating filter wheel. A ground station color converter later changes the sequential color signal to a standard NTSC color signal. This approach is new in that a simple and reliable method is used in the camera where it is most important and relegates the complexity of generating a compatible broadcast signal to the ground where it is readily handled.

The Apollo 11 spacecraft color television camera shown is 17 inches long including the zoom lens, weighs only 13 pounds (weightless in space) and is completely self-contained. A small four-wire cable containing a single d-c input voltage and a composite video output suitable for modulating the transmitters was the only connection required. During the space flight a small viewfinder monitor (also shown) was used to assist the astronauts in aiming and focusing the camera.

Besides providing real-time communications useful to NASA ground personnel and the public, the camera provides another scientific feature. The calibrated color filter wheel could allow true color information to be obtained by proper data reduction of recorded video transmission.

A general diagram of the color television system is shown in Figure 1. The image is focused by the lens through the filter wheel onto the faceplate of the image tube. As the wheel positions a red filter in the field, the image tube stores the red information of the scene being viewed and then reads it out. This information is processed by the electronics of the camera and is sent to the miniature monitor and to the transmitter. The same is true for the green and blue filter.

In Apollo 10, 11, and 12, the field sequential color signals were sent to the earth by the command module S-band transmitter. The received signal was fed into two tape recorders to compensate for doppler shift while presenting the information in real time. The doppler shift in frequency is caused by the motion of the spacecraft in relation to the earth. This was done by recording the information as it was received in the first unit and re-recording it in the second unit. The second tape unit was driven by the subcarrier standard frequency received from space. Since the subcarrier frequency had the doppler shift, the speed of the second tape unit varied in accordance with the shift and thereby compensated for the shift in the video. Due to the necessity for re-recording at the compensated rate, there was, at the most, a delay of only about 10 seconds from input to output.

After doppler shift compensation, the sequential color information was put into the scan converter which is a storage and readout device. The converter holds two previous fields in memory and upon receiving a new field presents the three fields at the output. As the new field is placed into memory the oldest field is erased, updating the information at the field rate.

A block diagram of the color camera is shown in Figure 2. Almost 70 percent of the functional blocks are integrated circuits exclusive of the power supplies.

The camera consists of three sections, the first being a monochrome camera with the addition of synchronization, pulse forming, and drive circuitry for the color adaptation. The second section is attached to this camera forming the housing for the transformer and motor, and finally, the section containing the motor, gearing, and filter wheel assembly which also serves as the mounting for the lens.

The camera input voltage is 28 ± 4 volts dc using 20 watts nominally. Its output is a standard EIA format at color standard frequencies with the exception that it does not carry the color burst which is added on the ground. It is a black negative signal from -0.75 to +2.75 volts into 100 ohms constrained within 20 percent to prevent overdevia-

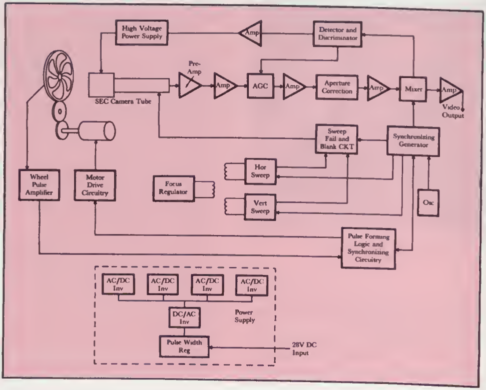


FIGURE 2

tion of the transmitter.

The bandpass of the camera is 4.5 MHz with a 20 dB/octave roll-off, therefore having a theoretical limiting horizontal resolution of 360 television lines/vertical dimension. Due to the fact that the signal-to-noise ratio is high and that the roll-off is finite, more extensive calculations and experience have shown the resolution to be in excess of 425 TV line/vertical dimension.

The system limiting horizontal resolution is set by the bandpass of the command module transmitter and is less than 2 MHz resulting in slightly more than 200 horizontal television lines referenced to the vertical dimensions, which again exceeds the theoretical limit because of an even higher signal-to-noise ratio and finite roll-off. Since the signal-to-noise ratio was high, approximately 40 dB for a broad scene, it was decided to include aperture correction to boost the image tube 200 TV line response by 40 percent, which also improves the resolution.

The Apollo color camera controls are limited to one switch associated with the electronics and the common lens adjustments of focus, iris, and zoom. The switch is used to change the automatic light control detector from an averaging type for "inside" scenes to a peak-detector type for "outside" scenes. A typical scene for the "outside" mode would be the earth subtending one-third of the vertical field of view.

The lens is a standard commercial unit that has been extensively modified. The most significant modifications were changing the format from a 12.7 mm to 25 mm and changes to qualify the lens for space use.

The color wheel has six sections comprised of two sets of red, green, and blue filters. This configuration is dictated by the speed of the motor, 1,798.2 r/min, and the gear ratio, 3:1. The color wheel then rotates at 599.4 r/min or 9.99 r/s to yield six fields per revolution at the standard vertical color frequency of 59.94 hertz.

Because of size limitations, it was necessary to use a small color wheel. This necessitated a special filter segment design to obtain optimum size, transmission efficiency, and uniformity.

Interspersed between the filters are opaque regions, a compromise accompanying the use of the 3-inch color wheel. Its necessity is explained as follows. As a red filter rotates past the image tube faceplate this light information is integrated by the target. The electron beam must move across the target, while scanning, in synchronization with the filter wheel. To prevent mixing with the next color, green, an opaque region is located on the color wheel between the color filters. The size and shape of the opaque region is determined by the wheel size and stability of the scanning beam and wheel rotation. The synchronization of the wheel position and the scanning electron beam position is accomplished by knowing the relative position of the wheel and using that information to set the scanning beam. The principle is shown in the block diagram. A pickup device senses the wheel position, the signal is amplified and

"Spacecraft Camera and Monitor (Westinghouse)"

sets the synchronizing generator which controls the sweep circuits and causes the beam to be in the right position.

The ability of this system to keep the scanning beam in the opaque region depends to a large extent upon the stability of the synchronous motor which is only as good as its input frequency. It is necessary to maintain a highly stable motor drive frequency.

As a result of frictional load shifts and motor hunting, the filter wheel has some unpredictable motion. To compensate for this, the size of the opaque region is increased.

The input power to the motor is approximately 11 watts at nominal input voltage. If a class A driver were used to drive it, the total power would have exceeded 30 watts; therefore, it was decided to drive it with a pulse input resulting in a total power consumption of approximately 12 watts.

The filters are dichroic depositions selected for maximum transmission and spectral response. When modified by the spectral response of the S20 photocathode and a daylight source their response closely matches that of the P22 phosphor. These filters are deposited on one piece of glass and sealed by another.

SEC CAMERA TUBE

The SEC camera tube consists of three main sections: image section, SEC target assembly, and hybrid gun. The scene is optically imaged on the photocathode, causing electrons to be emitted by the photocathode material. These electrons are accelerated by the high potential between the photocathode and the SEC target. This target, the unique feature of the SEC camera tube, consists of an aluminum oxide layer, a very thin layer of aluminum, and a low-density KC1 film.

When the accelerated electrons strike the target, they pass through the aluminum layer and strike the KC1 film. Secondary electrons released by the KC1 film are collected by the signal plate and the wall screen leaving a charge pattern in the KC1 film. Since the resistance of the film is high, it can hold the charge pattern for long periods until discharged by the reading beam.

The reading beam is supplied by a vidicon-type gun, a hybrid arrangement with electrostatic focus and magnetic deflection (electrostatic focusing permits simple external circuitry and has low power requirements). As the reading beam scans the target, the beam current discharges the KC1 film back to cathode potential. This discharging action produces the video signal.

An important characteristic of the SEC target is that it is almost completely discharged by the beam, leaving negligible signal pattern for the next readout unless recharged by the scene. This eliminates the image smear problems that occur with vidicons and orthicons at low light levels. Of course, smear will occur if the image is moved within a frame period.

Electron gain of the SEC target provides target gains in excess of 100. With an S20 photocathode, the combined sensitivity of the image section and the SEC target is typically 10,000 uA/lumen. Since target gain is a function of the accelerating potential, target gain is controlled by adjusting the accelerating potential (-2 kV to -m kV).

FUTURE COMPACT TV CAMERA APPLICATIONS

The utility of television aboard spacecraft and in manned planetary landings has been proved beyond all doubt. The amount of public interest in space television was shown particularly in Apollo 11 to be significantly greater than anticipated. During the Apollo 10, 11 and 12 flights the astronauts showed some other applications when they televised the crew, indicating their condition, and the unusual condensation in the tunnel for ground support evaluation. There are a multitude of other applications, mostly in the area of remote viewing for inaccessible locations and hostile environments.

NASA is planning extensive use of closed-circuit television on future missions. In the larger spacecraft and areas such as the S IV-B workshop, television will be used for on-board monitoring. Many activities will be undertaken by one man and the other crew members can monitor his movements on television for routine observation and safety. Closed-circuit color television with higher resolution than commercial television, is planned for much of the monitoring.

Some real-time television links are planned for transmission back to earth. Lunar roving vehicles may use television for guidance, control and navigation.

MARS REVISITED—CONTINUED FROM PAGE 25

INFRARED RADIOMETER: The heat radiated by areas approximately equal to those covered by the Mariner 6 narrow-angle TV images was measured during the Martian day and night. At the Martian noon, the temperature reaches a maximum of 60°F., while during the night it falls below -100°F. Variations in temperature have been detected which provide the absorbing properties of the soil and its ability to retain heat during the night. The preliminary analysis of the data suggests that the surface is a very good heat insulator, in fact, better than any known solid material on Earth.

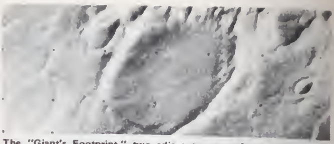
Primary objective of the Mariner 7 IR radiometer experiment was to measure the temperature of the polar cap in order to ascertain whether it is made of frozen CO_2 or H_2O. The 200 measurements made while Mariner 7 pointed towards the cap shows a flat temperature profile with a minimum of -190°F. which is in close agreement with the frost point of CO_2 at the basin pressure on Mars.

This agreement is taken as very strong circumstantial evidence in favor of the theory that the polar caps are, in fact, predominantly made of CO_2 rather than of water ice.

S-BAND OCCULTATION: The results from Mariner 6 show that near the region of Meridianii Sinus, the surface atmospheric pressure was found to be about 6.5 millibars (Earth is 1013 millibars) and the surface temperature about -9°F. At an altitude of about 82 miles, an ionosphere was observed. A smaller ledge of ionization was observed at an altitude of 63 miles.

The Mariner 7 results revealed a pressure of 3.5 millibars and a temperature of 205°K (-90°F) was obtained at a

This picture was taken by Mariner 7 as it neared its closest approach to Mars. The Martian south pole is located in the lower right portion of the photo. Apparent are numerous snow-drift-like formations, some of which appear to be related to local relief.



The "Giant's Footprint," two adjacent craters foreshortened by oblique viewing of the south polar cap of Mars.

latitude of 59°S and longitude of 28°E. The low value of surface pressure may indicate that this region (near Hellespontica Depressio) is substantially higher than the average (about 4 miles).

CELESTIAL MECHANICS: By analyzing three months of data from Mariners 6 and 7, it has been possible to determine a ratio of the mass of the Earth to that of the Moon of 81.3000 with an uncertainty of 0.0015.

The mass of Mars is determined to be about one-tenth the mass of the Earth; the exact figure is 0.1074469 ± 0.0000035. The only other precise determination of the mass was obtained from the Mariner 4 Doppler data. A recent re-examination of these data by George W. Null at JPL indicates a value 0.1074464 with an uncertainty of ± 5 units in the last place; Mariners to Mars in 1964 and 1969 agree very well in their determinations of the mass.

CONCLUSION:

The Mariner Mars 1969 Project provided the United States' second successful exploration of Mars. It followed the 1964-65 flight of Mariner 4, the only other spacecraft to have photographed another planet.

Two hundred television pictures of Mars were taken by the two Mariners, including 57 high and medium resolution views of selected Martian surface areas from an altitude of only a few thousand miles. The bulk of the photos was taken as Mariners 6 and 7 approached Mars and the planet revolved through several Martian days.

The data, when thoroughly analyzed, should increase significantly our understanding of the atmosphere and surface of Mars, provide global and local maps and, by inference, contribute to a better understanding of the biological status of the planet. Furthermore, the further analysis of the Mariner '69 data should yield information on the shape of the gravitational field and on the orbit of Mars itself. This will be important to future, more advanced missions to Mars and to an extended analysis of the data for the general relativistic effects.

In the middle 1970's two Mariner-class vehicles will orbit Mars for three months, and later in the 1970's there will be another mission, Project Viking, in which two spacecraft will orbit Mars and detach landing craft to descend to and operate on the surface of Mars.

The purpose of this analysis should be to eliminate information redundancy, and to extract hidden information from the data. Once done, this should decrease the amount of "noise" introduced in the process.

Three stages may be associated in the analysis of medical data:

(1) Interpretation or conversion of data into digital form;

(2) Statistical and mathematical treatment of the data;

(3) Comparative analysis of the data (comparison of the quantitative characteristics obtained with certain constants).

The *first stage* is the most difficult one to successfully complete. If the interpretation and conversion of the data is done by "man" rather than by "machine," subjectivity and simple mental strain may tend to increase the amount of error introduced in the data. Interpretation errors will affect the entire subsequent course of analysis.

This is the place where interdisciplinary groups will have the biggest impact in medical diagnosis. Automated methods of data collection and analysis, like for the ECG (Steinberg et al., 1962), are necessary to reduce error and subjectivity introduced by man.

The *second stage* in the analysis of medical information consists of statistical and mathematical treatment.

There are many benefits to be reaped from the application of mathematical techniques to medical data. There are also many pitfalls of which the investigator should be aware. When statistically investigating the results of biological measurements, we are always dealing with a random sampling of general quantities. The variance of the data in a random sampling depends on the variations induced by the very nature of the biological objects, as well as variations associated with vital processes. At any time t_0, the condition of a biological process differs from its preceding state $t_0 - t_1$, and its subsequent state $t_0 + t_1$. Therefore, averaging determines only the constant or average component of the process, and cannot characterize the state in its present condition.

In general, data may be generated by either *stationary* or *non-stationary* processes. Stationary processes are characterized by the law of probability distribution functions. These processes are such that if at any time t_0, we determine certain properties like average, standard deviation, etc., at any other subsequent time t_1, these values would remain constant. Non-stationary processes, on the other hand, do not exhibit this property. A good example of a non-stationary medical signal is the electroencephalogram (EEG). This is a signal whose basic statistical properties do not remain constant. In light of the above, the investigator must be very careful when analyzing the data.

In the *third stage*, the results of the statistical and mathematical analysis are compared with known constant values. When a physician examines a person, he is subjectively comparing him with values that he considers normal. From the mathematical point of view, the operations which take place in the physician's brain are extremely simple. From the cybernetics point of view, however, they are very complicated because of the psychological elements which enter into the decision-making process which are not readily subject to mathematical treatment.

This comparison with known values depends on the quality of the collected information, and on the correctness of the "known" values or constants. The comparison should be of a dynamic nature. The body maintains a relatively stable state of equilibrium through a series of interacting physiological processes known as homeostasis. A simple example is what happens when we exercise: as we use our muscles, they require an increase in their supply of oxygen to be able to function. The body responds to this demand by increasing the heart rate which in normal persons is equivalent to an increase in cardiac output.

This is why the comparison should be dynamic. It should be dynamic with respect to the environment present when the measurements were taken. A heart rate of 120 beats per minute may be considered abnormal in healthy persons, but if this is measured after exercise, the concept of abnormalcy disappears.

The known values or constants should also be in constant evolution to incorporate changes in the population and the environment.

Diagnosis

The final step in the diagnostic process is the evaluation of the collected and analyzed data. The result of this evaluation is the diagnosis.

A diagnosis involves a number of statistical, mathematical and logical procedures which are accomplished by each physician as a single psychoanalytical act.

Two sets of variables enter into this thought process;

(1) Data on the patient, free from redundancy and errors, which represent a set of symptoms.

(2) The physician's medical experience and knowledge, acquired as a result of study and practice.

One of the biggest challenges in medical cybernetics is that of describing the thought processes which take place in a physician's mind when a diagnosis is made.

This article affords but a small glimpse into the intricacies of medical cybernetics. We presented in a simplified manner the patient + physician=diagnosis process. The next two articles in this journal will be devoted to two aspects of this complicated process:

(1) the multiphasic screening clinics, which fit into the

"collection of information" and "analysis" stages, and

(2) the automated patient monitoring system, which forms part of the process as a continuing data gathering system.

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* * * * *

SHAFTED AGAIN

Sign in front of a crematorium: "We're hot for your body."

* * *

The forgetful professor had left his umbrella in his hotel room when checking out; he missed it on the way to the train station and, still having time to spare, he hurried back. He found the room and was about to ask a passing chambermaid to open it for him, when he became aware of voices within and realized that, in the brief time since his depature, the room had been let to new occupants.

"Whose little baby are you?" asked a youthful male voice from behind the door, and the question was followed by the sound of kisses and a girlish giggle.

"Your little baby," said the youthful female voice.

"And whose little hands are these?" asked the boy.

"Your little hands," responded the girl, with more giggles of delight. "And whose little knees . . . and whose little. . ."

"When you get to an umbrella," said the professor through the door, "it's mine!"

* * *

Then there was the little boy who was interrupting his busy mother. "Mommy, do you know what Daddy and the hired girl did last night while you were bowling?"

"No, Junior, what did they do?"

"Well, first Daddy took off all his clothes, and . . ."

"Hold it right there. Remind me about this when Daddy comes home for supper."

Later that night: "What was that you were telling me this morning about Daddy and the hired girl?"

"Well, first Daddy took off all his clothes, and then the hired girl took off all of hers, and then they did what you and Uncle Joe did when Daddy was out hunting last month."

* * *

Paul Revere's horse galloped down the country road. The life of the colonies depended on his warning the people that the British were coming. He approached a farmhouse.

"Is your husband at home?" he called to the woman feeding chickens in the yard.

"He's back in the barn, Paul," she said.

"Tell him to get his musket and go to the village square. The Redcoats are coming!"

The exchange of words had taken but an instant; Revere's horse had not broken its stride. The famous patriot thundered off toward the next farm.

"Is your husband at home?" Revere called to the woman in the doorway of the next farmhouse he approached.

"He's asleep in his room, Paul," she said.

"Tell him to get on his clothes," Revere cried. "The Minute Men are meeting at the village square. The British are coming!"

Horse and rider galloped on to still another home.

"Is your husband at home?" he called to the handsome woman who leaned out the window.

"He's gone to New Amsterdam and won't be back till Sunday," she said.

"Whoa-a-a!"

* * *

Our Word Book defines *race horse* as an animal that can take several thousand people for a ride at the same time.

* * *

A Chinese scholar was lecturing when all the lights in the auditorium suddenly went out. Unperturbed, he asked the people in the audience to raise their hands. They did, and the lights immediately came on again. "Proves wisdom of old Chinese saying," he remarked. "Many hands make light work."

* * *

A metallurgist is a man who can look at a platinum blonde and tell whether she is a virgin metal or a common ore.

Why would any good engineer go to work in a factory?

That's sort of like asking why a banker goes to work in a bank.

A guy goes to work where the best work is. And some of the best engineering work around today is in and around factories.

What would you say to designing the numerical control system for an automated steel mill?

Or developing quality control procedures for the world's most powerful airplane engine?

Or managing a production team responsible for delivering power generation equipment to utility customers?

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And where will you find those managers today? Running our factories, of course.

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